GRC Environmental Programs Manual

Chapter 39 – Laser Safety Program

NOTE: The current version of this Chapter is maintained and approved by the Environmental Management Office (EMO). The creation date for this chapter is May 2004. The current version is maintained on the Glenn Research Center (GRC) intranet at http://osat-ext.grc.nasa.gov/emo/pub/epm/epm-contents.pdf. Approved by: EMO Chief, Michael Blotzer {mailto: Michael.J.Blotzer@nasa.gov}

PURPOSE

This chapter provides requirements for the safe use of lasers and laser products at the Glenn Research Center's Lewis Field and Plum Brook Station.

APPLICABILITY

This chapter is applicable to all civil servant and contractor employees assigned to GRC sites and to any NASA-controlled, government-owned facilities associated with GRC. This document applies to the operation of lasers at wavelengths between 180 nanometer and 1 millimeter. Examples of lasers and laser systems that this document applies to may include

- Commercially available lasers that are used as a part of an experiment or laser development.
- Commercially available lasers that have been modified, assembled or incorporated into a device built by GRC personnel.
- GRC-designed or -built lasers or laser systems.
- Commercially available devices utilizing high power lasers for heat-dependent activities such as welding, parts prototyping, or laser cutting
- Commercially available devices utilizing lower power lasers for analytical or construction-related activities.

This document does not apply to lasers incorporated into certain commercially other available devices used by the general public, unless opened, serviced, modified, or incorporated into a device built by or for GRC, or as specifically addressed in this document. Although misuse of these lasers may pose a hazard, it is generally accepted that the risk of injury from these devices is minimal if used as intended by the manufacturer. Examples of these lasers and laser systems not covered by this document include CD players, laser printers, and laser pointers.

DEFINITIONS

Accessible Emission Limit (AEL) – The maximum accessible emission level permitted within a particular class.

Aperture – An opening or window through which radiation passes.

Attenuation – The decrease in the radiant flux as it passes through an absorbing or scattering medium

Aversion Response – Closure of the eyelid, or movement of the heat to avoid an exposure to a bright light. The aversion response to a bright laser source will occur within 0.25 seconds.

Beam Splitter - An optical device which can produce two beams from a single laser beam by controlled reflection

Construction Laser – commercially available laser products used for construction tasks such as alignment, surveying or positioning. These lasers are limited to Class 3a emission limits for visible lasers (0.4 – 0.7 μm) and Class 1 output for other lasers.

Construction Laser Operator – individual who has received appropriate training for safe use of construction lasers and is also qualified to operate such lasers by their employer.

Continuous Wave Laser (CW) - A laser which emits for more than 0.25 seconds

Diffuse Reflection - When an incident laser beam is reflected over a wide range of angles

Irradiance – Radiant power incident per unit area upon a surface, expressed in watts-per-square-centimeter (Watts/cm^2). It is used to characterize a CW laser. Synonym: Power density.

Laser - Acronym for Light Amplification by Stimulated Emission of Radiation - A source of intense, coherent, directional beam of optical radiation

Laser Controlled Area - An area containing one or more lasers where the activity of personnel is subject to control

Laser Device - Either a laser or a laser system

Laser System - An assembly of electrical, mechanical and optical components that include a laser

Laser User & Laser Operator - Used interchangeably as a person who uses a laser or laser system

Laser User Requirements - Actions, tools, equipment deemed necessary for safety and to monitor biological effects of laser use

Maximum Permissible Exposure (MPE) – The level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin.

Nominal Hazard Zone (NHZ) - The space within which the level of the direct, reflected, or scattered radiation during normal operation exceeds the applicable MPE. Exposure levels beyond the NHZ are below the appropriate MPE level.

Nominal Ocular Hazard Distance (NOHD) – The distance along the axis of the unobstructed beam from a laser, fiber end, or connector to the human eye beyond which the irradiance or radiant exposure, during installation or service, is not expected to exceed the appropriate MPE.

Optical Density - Logarithmic expression for the attenuation produced by an eye protection filter.

Pulsed Laser - A laser which emits for less than 0.25 seconds

Pulse-Repetition Frequency (RPF) – The number of pulses occurring per second, expressed in hertz.

Q-Switched Laser - Emits high peak powers for extremely short duration (nanoseconds)

Radiant Exposure – Surface density of the radiant energy received, expressed in units of joules-per-centimeter squared (J/cm^2). It is used to characterize a pulsed laser.

Repetitively Pulsed Laser - A laser which has a re-occurring pulse repetition rate

Semi-Conductor/Diode Laser - Types of lasers that produce low average power outputs

Shall - Indicates a requirement that is necessary to meet the standards of protection currently in effect

Should - Indicates a recommendation that can be applicable

Specular Reflection - Reflections from shiny surfaces

BACKGROUND

A laser is a device that produces an intense, coherent directional beam of light energy. GRC personnel use many types of lasers, some posing little hazard to users and others that could cause significant harm if used improperly. The light characteristics of these lasers vary greatly. Wavelengths of emissions can range from the lower ultraviolet (UVA) to the far infrared (FIR). Emissions can be continuous wave (CW) or pulsed. Power output can range from nanowatts to kilowatts.

As stated, using any laser involves exposure to varying degrees of hazards. Most lasers at GRC can injure the eyes of anyone who looks directly into the beam or its specular (i.e., mirror-like) reflection. In addition, diffuse reflections created by some high-power laser beams can cause permanent eye damage. High-power laser beams can also burn exposed skin, ignite flammable materials, and heat materials so that they release hazardous fumes, gases, debris, or ionizing and non-ionizing radiation.

> ***Note:*** *The most common hazard when working with lasers is eye injury. To prevent such an injury, workers shall avoid looking directly into the laser beam or its specular reflections. This rule shall be followed regardless of the protective eyewear worn or the type of hazard classification of laser unless specifically authorized in support of research being conducted.*

The classification of lasers and laser systems is based on their ability to cause injury. Class 1 lasers (or laser systems) pose no hazard if used in their designed state. Class 2 and 3a lasers are considered low- to medium-hazard lasers and could cause eye damage if viewed directly and intentionally. Class 3b and 4 lasers are considered high-hazard lasers and require more stringent controls. Equipment and optical apparatus required for producing and controlling laser energy also introduces other hazards, including high voltage, high pressure, cryogenics, noise, additional radiation, flammable materials, laser dyes and solvents, and toxic fluids.

POLICY

This document describes the different types of lasers used at GRC, their classifications, and the required controls for each classification. It describes the responsibilities of personnel who work with or supervise laser operations and identifies the training required for all GRC operations involving laser use. Unless specifically stated otherwise in this document, work standards for the safe operation of lasers and laser systems at GRC shall follow the recommendations of ANSI Z136.1 – 2000, "American National Standard for Safe Use of Lasers" and ANSI Z136.6 – 2000, "American National Standard for Safe Use of Lasers Outdoors."

RESPONSIBILITIES

Laser Safety Committee (LSC) Members – to participate in or, if designated by the LSC chairperson, lead laser safety permit evaluations and, as needed, provide guidance to the safety permit requester on conditions of safe laser use. LSC members will provide input to the committee chair regarding the acceptability of the proposed laser activity being evaluated.

Laser Safety Committee Chairperson (LSCC) – to lead laser safety permit evaluations and provide guidance to the safety permit requester on how to satisfy permit conditions. The LSC chair also approves laser safety permits and has discretionary authority to waive permit requirements as conditions may dictate.

Laser Safety Officer (LSO) – to ensure laser activities are conducted in accordance with NASA guidelines and recommendations made in the ANSI Z136.1 and Z136.6 standards for the safety use of lasers. The LSO is not necessarily the LSC chairperson.

Laser Safety Permit Requester – to follow the GSO process for obtaining a safety permit and to work with the laser safety committee in satisfying conditions for the permit.

Laser User – to satisfy training and medical surveillance requirements of this chapter in addition to working in a safe manner in accordance with established procedures for their lab/area/room/cell. Laser users should express their concerns or questions regarding potential laser safety issues to their management or to the LSO.

Laser User's Supervisor – to ensure laser users meet requirements specified in applicable laser safety permits or by any laser facilities.

Laser Facility Supervisor – to ensure facility satisfies conditions for safe laser user designated by the laser safety permit or local procedures and to verify that laser users/operators are following applicable procedures and safety precautions for the area.

Construction Laser Operator – to obtain training and to become qualified for construction laser use and to operate such laser products in accordance with the manufacturer's specifications and to follow general safe use practices. The Construction Laser Operator is required to maintain proof of his or her qualification in their possession at all times during laser use.

GRC Medical Services – to maintain complete, accurate records of all laser medical examinations for personnel in the medical surveillance program. Records are to be retained for at least 30 years. Results of examinations are to be discussed with employees as needed. The occupational health physician is also responsible for identifying examination elements following a laser exposure incident.

Glenn Environmental Management Office (EMO) Chief – to provide support to the laser safety officers in the performance of their duties.

Glenn Safety Office (GSO) Chief – to provide support to the laser safety committee chairperson in the performance of their duties.

REQUIREMENTS

> ***Note:*** *The use of construction lasers is addressed in section "REQUIREMENTS – CONSTUCTION LASERS"*

Training

General Laser Safety Training

Laser safety training is required for all individuals who use or operator Class 2 or higher lasers. The source, content and periodicity of this training are specified by the Glenn LSO. Instruction can consist of viewing training videos (at the Learning Center), classroom instruction, on-line presentations (i.e., SOLAR), or computer-based training (CBT). Laser safety training is required for operators/users prior to working with lasers. In addition, periodic refresher training will be offered every two years (biennially) and individuals identified as laser operators will be required to complete this training.

Facility Laser Instruction Training

Laser users/operators must also satisfy training/work experience requirements specified for the area/room/cell/lab where the lasers are present. These requirements may be specified on the C-580 form, "Qualified Operators List," associated with a laser safety permit, or in the local procedures for the area. Typically, users/operators will receive instruction on the specific hazards of the laser(s) used in the area along with protection measures employed to ensure risks are minimized.

Other Training

The LSO may periodically coordinate more advanced laser safety training for GRC personnel.

Medical Surveillance

Eye Examination: Pre-use

Operators of Class 3b through Class 4 lasers are required to receive a baseline eye examination before use. This examination entails ocular and medical histories, visual acuity, Amsler Grid Test, and color vision tests as described NPG 1800.1, NASA Occupational Health Program Procedures.

An individual requiring an exam, or their supervisor, can contact the Laser Safety Officer or Medical Services to receive directions on scheduling the activity. Arrangements with one or more local ophthalmologists have been made for receiving the examination per NASA guidelines. Civil servants will receive their exam from a one of these contracted physicians, the cost of which is paid through Glenn Medical Services. Contactor employees required to obtain a baseline exam may also use one of these contracted doctors. Medical Services, however, does not cover the cost of their examinations.

The individual receiving the exam will provide the ophthalmologist with the "LASER OPERATOR EYE EXAM CLEARANCE" form. (attachment to this procedure and available from the LSO or Medical Services) An equivalent letter from the doctor's office, which includes the patient's name, date of the examination and a recommendation based on its results, is also acceptable. The physician's office will forward this form/letter to Glenn Research Center's Medical Services, which, in turn, will forward a copy to the Laser Safety Officer. The examinee should also retain the copy they receive for their records.

This examination policy also applies to students, interns and other temporary laser research personnel. Exams costs for co-op students will be handled in the manner similar to civil servants. The Glenn LSO and Occupational Health Physician will approve of any exceptions to this policy according to the special circumstances of the case.

Skin Examination: Pre-use

Examination of the skin is not required for preplacement examinations of most laser workers; however, it is suggested for employees with history of photosensitivity who are working with ultraviolet lasers. Any previous dermatological abnormalities and family history are reviewed. Any current complaints concerned with the skin are noted as well as the history of medication usage, particularly concentrating on those drugs which are potentially photosensitizing

Eye and/or Skin Examination: Post-incident

Any employee with a known or suspected laser eye and/or skin injury, should contact Glenn Medical Services to arrange for a post-exposure exam. This exam will include those items listed above as deemed necessary by the facility Occupational Health Physician.

Signs

Signs shall be posted in visible locations at/near access points to facilities where Class 2 and above lasers are used. General requirements for signs are below. Note, "Caution" signs will have black letters/sunburst on a yellow background while "Danger" signs will have red (and some black) letters/sunburst on a white background. Also, verbiage can vary somewhat on signs in order to convey specific information that is pertinent to the laser in use. The LSO should be consulted when questions about postings, signs or labeling exist; they will provide direction to the laser facility supervisor.

Class Warning Signs – required for all areas where Class 2 and above lasers are in use.

Class 2 Warning Sign

- A "Caution" sign
- Verbiage above the sunburst: "Laser Radiation, Do Not Stare Into Beam"

- Verbiage below the sunburst should include information about the laser…type, wavelength, power or energy/pulse rate.
- "Class 2" in the lower right-hand corner of sign

Class 3a Warning Sign (Most Class 3a lasers require "Danger" signs and labels. A few, however, qualify to use the signal word "Caution.")

- A "Danger" sign
- Verbiage above the sunburst: "Laser Radiation, Avoid Direct Eye Exposure"
- Verbiage below the sunburst should include information about the laser…type, wavelength, power or energy/pulse rate.
- "Class 3a" in the lower right-hand corner of sign

  - OR -

- A "Caution" sign
- Verbiage above the sunburst: "Laser Radiation, Do Not Stare Into Beam or View with Optical Instruments"
- Verbiage below the sunburst should include information about the laser…type, wavelength, power or energy/pulse rate.
- "Class 3a" in the lower right-hand corner of sign

Class 3b Warning Sign

- A "Danger" sign
- Verbiage above the sunburst: "Laser Radiation, Avoid Direct Exposure to Beam"
- Verbiage below the sunburst should include information about the laser…type, wavelength, power or energy/pulse rate.
- "Class 3b" in the lower right-hand corner of sign

Class 4 Warning Sign

- A "Danger" sign
- Verbiage above the sunburst: "Visible and/or Visible Laser Radiation, Avoid Eye or Skin Exposure to Direct or Scattered Radiation"
- Verbiage below the sunburst should include information about the laser…type, wavelength, power or energy/pulse rate.
- "Class 4" in the lower right-hand corner of sign

Other Signs

Specific Message Signs – Specific messages may be written on white/red & black "Danger" or yellow/black "Caution" signs with sunbursts. Examples of such pertinent precautionary instructions could include "Laser Alignment in Progress, Appropriate Eye Protection Required for Entry," "Restricted Area," "Do Not Enter When Light is ON," or "When these Enclosure Panels are Removed, This Area is Within a Laser Hazard Zone." Laser and class information could also be included on this sign, allowing it to satisfy the requirement for a "Class" warning sign.

Laser Controlled Area – A yellow/black "Caution" sign with sunburst may be placed at the entrance to a room/area designated as being within the nominal hazard zone of a laser. One use example would be in a facility where there is no clear delineation for the laser area, such as in a high bay area that may house several different technical activities. This will alert incoming personnel that a laser may be in operation. The "appropriate wording" can be any instructions the reader will need to know upon entering the area. Wording may specify "Authorized Personnel ONLY." A "Laser Controlled Area" sign would be in addition to the appropriate "Class" warning sign required above.

Temporarily Controlled Areas Signs – A white/blue & black "Notice" sign with a sunburst may be used to denote temporary controlled laser areas during periods of servicing or maintenance. Verbiage on such a sign would be "Laser

Controlled Area" or similar. The "Notice" sign is placed outside the controlled area while the appropriate danger warning (i.e. Class) sign is required within the controlled area.

Illuminated Signs – Warning signs that are illuminated during laser operation provide an added safety measure since they reduce any potential complacency, which can develop when signs are continually posted. Such signs are highly recommended for Class 4 laser operations, especially those involving non-visible wavelengths. They could be posted at the entrance to a laser-controlled area to serve as a warning to individuals not to enter, or they could be posted within the controlled area as a reminder to operators that the laser is firing. Appropriate verbiage for these two scenarios could be "Laser On – Do Not Enter" and "Danger – Laser On," respectively. Note, in the situation where the warning sign/light is placed within the laser-controlled area, the light should be visible through the operator's laser protective eyewear. An alternative to an "illuminated sign" would be a similarly operated warning light/beacon that is immediately adjacent to a sign specifying the desired message or warning.

Obtaining Signs

Standard laser signs can be obtained from the LSO or their designee within the Environmental Management Office. When signs are no longer needed for an area, they should be returned to the LSO. The LSO also has "Laser On – Do Not Enter" warnings that are used to create illuminated warning signs; the lighted box itself is not provided by EMO. Wording on signs can be varied somewhat using label-making machines or by other methods

Labels

The Food and Drug Administration (FDA) requires that laser products be labeled by the laser or product manufacturer. One exception to this requirement would be lasers provided to original equipment manufactures (OEMs) as components for manufacturing a product/system containing the laser. If such a laser was purchased, it may not be appropriately labeled and the individual purchasing this device would need to contact the LSO to ensure the laser is appropriately labeled and classified. In addition, the LSO should be contacted when alterations or modifications are planned for a laser device as these might affect the laser classification.

Also, it is worth noting that manufacturers may "over label" their laser devices. That is, provide a more "hazardous" label warning than is required. Manufacturers typically do this in an effort to simplify their labeling process by creating a generic label that works for a group of lasers. Laser documentation should be consulted to confirm the exact class of the laser, or, such an inquiry can be addressed to the LSO. Again, the LSO should be consulted when questions about postings, signs or labeling exist; they will provide direction to the laser facility supervisor.

The specific laser labeling requirements are provided below.

Class Warning Label – Class 2 and above lasers

Lasers must be labeled with the appropriate Caution or Danger label, based on the laser's class. The label specifications are identical to the class warning sign requirements specified above. If the laser is embedded within a device or housed in an enclosure, an appropriate label needs to be placed on this outer surface to provide the needed warning.

Aperture Label

An aperture label is required on a laser or laser device to identify the laser emission point. Typically, this is a small label with an arrow pointing to the location of the beam output.

Other

As with signs, labels can also be used to communicate specific messages about a laser product. For example, a danger label reading "Removal of this Panel makes this system a Class 4 Laser Device" could be applied to a removable panel on a Class 1 system containing an embedded Class 4 laser.

Laser Standard Operating and Alignment Procedures

Class 3b and 4 lasers must have written standard operating and alignment procedures that are approved by the LSO. These procedures are typically provided to the Laser Safety Committee Chairperson (LSCC) during the safety permit request process. If the LSC chair is not also the LSO, they will forward the procedures to the LSO for review and approval. The LSC Chairperson will keep record of the LSO's approval on file with the corresponding laser safety permit. If the LSO and LSC are one-in-the-same individual, the LSC Chair's signature on the laser safety permit (form C-919) shall denote their approval of the attached procedures.

The written procedures should include a description of the laser(s) being used as well as the specific steps followed to ensure the device is being used safely. These steps may include a checklist of precautions to be observed or followed prior to laser activity. Specifications for laser protective eyewear should also be included in the procedures by indicating the required Optical Density (O.D.) for each wavelength of interest.

Laser alignment activities, in particular, can pose a significant ocular hazard to users and the procedures outlining the methodology of the task are critical to minimizing this hazard. Again, if there is potential exposure to laser radiation above the applicable MPE, then controls, including protective eyewear, need to be followed. Approaches to performing alignments include:

- Operating laser at lowest power setting that permits alignment.
- Reducing laser power via other means (neutral density filter, optical attenuator) during alignment
- Use of a coaxially-oriented low-power alignment laser
- Use of burn paper or paper or a material which fluoresces when exposed to the laser wavelength of interest.
- Wearing protective eyewear when laser intensities (irradiance or radiant exposure) exceeds the applicable MPE.
- Breaking down alignment activity into stages, the first being a "rough" alignment requiring various protective measures and the second being a "fine tuning" alignment involving more procedural and work practice control measures.
- Wearing skin protection (gloves, long sleeves) if aligning Class 4 lasers above the skin MPE.
- Clearing area/room/lab/cell of unnecessary personnel during alignment

Standard operating and alignment procedures do not need to reproduce detailed and complex laser operating procedures found in the manufacturer's instruction manuals. Rather, they can provide specific references to the procedures within such documents. As needed, the LSO or LSCC can provide some assistance in preparing the procedures.

Control Measures

When the intensity of an accessible laser beam exceeds the applicable maximum permissible exposure (MPE) level, appropriate controls must be implemented to minimize the potential hazards to laser operators and bystanders. These measures include both engineering and administrative controls, with the former being the preferred course of action. "Accessible" laser beams are those that are not enclosed or contained, and are oriented such that the direct beam or inadvertently-reflected beam could pose a potential eye or skin hazard. Beam accessibility is typically greater during laser alignment activities, necessitating greater controls.

Typical engineering controls include (but are not limited to) protective housings/enclosures, interlocked entryways or beam enclosures, key control, beam path enclosures, beam stops/dumps, beam attenuators to limit output level, and shades/curtains over windows. Common administrative controls include alignment and operating procedures, emission output limitations, the use of protective eyewear, the use of skin protection, education and training, and the use of temporary barriers and curtains. As mentioned, the use of engineering controls is typically favored over administrative controls since the latter relies on a human-dependent variable.

Entryway Controls

Because open-beam configurations are commonly found in research environments such as the Glenn Research Center, entryway controls are an important part our safe use practices. There are three basic options for controlling entry to a "laser controlled area." Entryway controls are required for Class 3b and 4 laser activities and the LSO is responsible for specifying the type of control required for a laser facility. The basic types are as follows:

Non-Defeatable Controls – These utilize a built-in interlock switch that will "turn off" the laser beam (either secure power or close a shutter) when an entry door is opened. Non-defeatable entryway controls are to be used for long-term laser operation.

Defeatable Entryway Controls – Similar to the "Non-Defeatable Control" described above with the addition of a temporary (typically 15 to 20 seconds) by-pass which will allow entry into an area without securing the beam. This type of control can be used if no laser beam hazard exists at the point of entry. Defeatable entryway controls are to be used for long-term laser operation

Procedural Entryway Controls – A door, blocking barrier, screens, curtains, etc. are used to block, screen or attenuate the laser radiation at the entryway. The laser radiation at exterior of these devices shall not exceed the applicable MPE, nor shall any personnel experience any exposure above the MPE immediately upon entry. Procedural entryway controls are used only for temporary laser activities and only with the permission of the LSO. Sufficient warning signs are an important part of implementing these short-term measures.

Class-Based Control Measures

The control measures described below are general in nature for the specific class of laser being used. The laser safety officer will make a final determination of what control measures will be required for a facility and can modify these general requirements on a case-by-case basis. Note, that laser classification during alignment activities may be higher than that during normal operation of some laser systems.

Class 2 Laser Control Measures

- Training, Signs, Labels (see above)

Class 3a Laser Control Measures

- Class 2 control measures, PLUS
- Protective Eyewear (if accessible beam intensity exceeds MPE)

Class 3b Laser Control Measures

- Class 3a laser control measures, PLUS
- Baseline Eye Examination (see above)
- Alignment and Operating Procedures (see above)
- Entryways Controls and/or Interlocked Beam Enclosures
- Key Controls

Class 4 Laser Control Measures

- Class 3b laser control measures, PLUS
- Skin Protection (if accessible beam intensity exceeds skin MPE)

Laser Safety Permit Process

Overview

All laser operations, except for Class 1 systems, require a laser safety permit. The safety permit process is described in Chapter 1A of the Glenn Safety Office's Safety Manual. The chairperson of the Laser Safety Committee may waive the need for a safety permit if the conditions of use for the laser satisfy Class 1 criteria or if, based on their judgment, the circumstances of use offer sufficient protection for a temporary activity. In either case, that decision is up to the LSC chair. When a safety permit is issued, the proposed laser operation is approved within the constraints listed on the safety permit, the corresponding qualified operators' list and on the procedures and other documentation supporting the permit.

Detailed

Requesters are encouraged to contact the chairperson of the laser safety committee directly prior to submitting their permit package if they have any questions regarding laser safety permits. As needed, laser safety committee members or the LSCC will assist the requester in identifying specific controls to be implemented or actions to be conducted to satisfy typical conditions of a laser safety permit. The "official" permit paperwork and supporting documentation are to be submitted to the Glenn Safety Office's safety permit clerk, who, in turn will log the request and forward it to the responsible safety committee chair (in this case the LSCC). At a minimum, the paperwork should include the permit request (C-923) or permit renewal/change request (C-590), a hazard analysis (C-923a), and a qualified operators list (C-580). Additional documentation provided with the request should include laser specifications and operating and alignment procedures.

Once the LSC chair receives the safety permit request (new or renewal/change), they will contact the "requester" designated on the permit to discuss the activity and, if needed, arrange a time for the evaluation or possibly an informal pre-evaluation, which would be followed at a later time by the formal LSC evaluation. Typically, laser safety permit evaluations are conducted by the chair of the laser safety committee (or their designee) and at least one other member of the committee. At their discretion, the chair can limit the evaluation of a permit request to one reviewer. Candidate scenarios for a single reviewer could involve a simple permit request involving a low-hazard laser or the renewal of a permit involving a non-changing activity with good documentation on file.

Like standard safety permits, laser safety permits are issued as a vehicle for assuring activities are conducted in a manner to minimize potential health and safety risks to employees. The scope of a laser safety permit is to address the eye and skin hazards associated with the use of the lasers. If an activity also involves non-laser hazards, then a second standard safety permit might also be necessary, whether or not these hazards are directly associated with the laser. For example, excimer lasers consume toxic (*health hazard*) gas in generating the desired ultraviolet wavelength, or a microgravity experiment involving a pressurized (*safety hazard*) fuel (*safety hazard*) cylinder may use a high power laser to visualize a combustion parameter. For each of these activities, both a standard safety permit and a laser safety permit would be required.

Safety permits can be issued to cover time periods ranging from a day to several years. The periodicity of the permit renewal is left to the discretion of the laser safety committee chairperson, who signs/approves the permit. Safety permits and the associated qualified operators' list are to be posted outside the lab/room/cell where the activity is being conducted. Completed permits (i.e., expired) are to be signed by the requestor and returned to the safety office per the procedures outlined in Chapter 1A of the Glenn Safety Manual.

REQUIREMENTS – CONSTRUCTION LASERS

Construction Laser Operator Training

Operators of construction lasers shall receive training on proper and safe use of the laser products they operate. This training should be offered or coordinated by their employer and should satisfy the OSHA construction standard for "Non-ionizing radiation." (29 CFR 1926.54) The employer for construction laser operators shall provide their

operators with documentation of their laser use qualification. Per the OSHA standard, this proof of qualification shall be available and in the possession of the operator at all times during laser use.

Controls for Using Construction Lasers

Physical control measures for construction lasers are typically not required because of the lower powers involved with such lasers. Construction lasers, as described in this document, include commercially-available products designed and intended for construction activities with power emissions satisfying Class 3a limits for visible lasers and Class 1 for other wavelengths. Intentional misuse of low power visible lasers, such as construction lasers, for the purpose of causing visual interference is prohibited. Visual interference with "critical tasks" by Class 2 or 3a lasers is possible if they are intentionally used at dusk or night near airports or roads. Consequently, the use of visible construction lasers is not permitted during such time periods. This should have little impact on construction activities as such construction lasers are typically not used at night and would not be expected to create a direct or indirect hazard when operated by a "qualified" operator and when used as intended.

When using construction lasers indoors, operators should consider potential ocular exposure to other construction workers and bystanders when planning their laser use. It may be necessary to temporarily secure rooms, hallways, cells, etc. during laser operation as a safety precaution. Methods of temporarily isolating such an area could include barricades, locked doors, signs, or having co-workers keep others away.

Procedures for Construction Lasers

Written Procedures for Safe Use of Construction Lasers

Contractors using construction lasers shall have established written procedures, which address, at a minimum, the following issues:

- use restriction to "qualified" persons
- efforts undertaken to minimize direct eye potential (verify beam path prior to firing, consideration of beam termination, not positioning at eye level, prohibiting intentional direct viewing, etc.)
- prohibited times of use (i.e., dust or night)
- for indoor laser use, specify if and how an area is to be temporarily secure during laser use.

Health and Safety Plan (HASP) for Construction Activity

The contactors laser use procedure shall be included in the HASP written for the involved construction task. The contractor should also provide the OSHA-required proof of qualification for their construction laser operator(s) with the proposed HASP. The Environmental Management Office representative charged with reviewing and approving HASP's shall approve the use of laser use on behalf of the LSO.

RECORDS

Laser Safety Permit (C-919) and supporting documentation – Maintained by permit requester, the Glenn Safety Office, and the Laser Safety Committee Chairperson.

Eye Exam Records (Baseline and Others) – Maintained by Medical Services

REFERENCES

- NASA Procedural Requirement, NPR 1800.1 NASA Occupational Health Program Procedures
- Draft NASA Policy on Outdoor Laser Use
- Chapter 1A, "Safety Permit System," NASA Glenn Safety Manual

- American National Standards Institute, American National Standards Institute For Safe Use of Lasers: Z-136.1 (2000), Publisher: Laser Institute of America, Orlando, Florida, 2000.
- American National Standards Institute, American National Standards Institute For Safe Use of Lasers Outdoors: Z-136.6 (2000), Publisher: Laser Institute of America, Orlando, Florida, 2000.
- Occupational Safety and Health Administration, Construction Health and Safety Standards, 29 CFR 1926.54 "Non-ionizing Radiation"
- U.S. Food and Drug Administration – 21 CFR 1040 – Performance Standards for Light-Emitting Products, Section 1040.10 "Laser Products"

Laser Operator Eye Exam Clearance Form

Safety and Assurance Directorate (SAAD)
Approved by: Environmental Management Office Chief: Michael Blotzer
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Creation Date: May 2004

LASER OPERATOR EYE EXAM CLEARANCE

For

OCCUPATIONAL MEDICINE SERVICES
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CLEVELAND, OHIO 44135
PHONE: 216-433-5841
FAX: 216-433-6529

EMPLOYEE NAME:_____SS#:_____

SUPERVISOR NAME: _____

☐**CIVIL SERVANT** ☐**OTHER(Contractor/Student)_____**

This employee presented today for an eye examination prior to working with the laser at NASA Glenn Research Center. The following tests were completed:

- ☐ **Vision Check**
- ☐ **Manifest Refraction**
- ☐ **Amsler Grid**
- ☐ **Tonometry**
- ☐ **Slit Lamp Exam**
- ☐ **Dilated Fundus Exam**
- ☐ **Fundus Photos**

This patient's diagnosis was as follows: <u>exam was within normal limits and is cleared for laser operation.</u>

Comments:_____

_____	_____	_____
Physician's Signature	**Date**	**Physician's Office Stamp/Info**

*****Please return this form to Occupational Medicine Services at the above address*****

_____ _____

Reviewed by: **Date**
Occupational Medicine Services
Singleton Health Services, L.L.C.

cc: GRC Laser Safety Officer